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UNITED STATES DEPARTMENT OF AGRICULTURE

BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE

FOREST INSECT INVESTIGATIONS

MEMORANDUM FOR FILES - FOREST INSECT LABORATORY,
COEUR D'ALENE, IDAHO

Re: Field Temperature Studies - Winter 1936-1937

By
James C. Evenden
Entomologist

Forest Insect Laboratory
Coeur d'Alene, Idaho
May 6, 1937

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Re: Field Temperature Studies - Winter 1936-1937

In an attempt to explain some of the variables associated with the mortality of overwintering bark-beetle broods as a result of abnormally low or unseasonal temperatures, the following field experiments were instituted at the Coeur d'Alene Laboratory in November 1936:

(1) Effect of elevation on air temperatures.

(2) Relation of diameter to subcortical temperatures of insect-infested trees.

Though it was realized that these experiments were not organized in sufficient magnitude to offer conclusive results, they were established with the view of securing information as to the trend which more complete data would follow. Most of the field work in connection with that part of the first experiment conducted at the Coeur d'Alene Laboratory was performed by Mr. Gibson, with Messrs. Terrell and Bedard making a few of the reading. In the second experiment the field work was performed by Messrs. Bedard and Hunt, with the writer assisting with a few examinations.

EFFECT OF ELEVATION ON AIR TEMPERATURES

Weather Bureau records demonstrate that during periods of extreme

cold, warmer temperatures will be found at the higher elevations of an area than in the valleys or bottom lands. This condition was appreciated in past attempts to utilize temperature records from official Weather Bureau stations as an index of conditions which occurred in forested areas a few miles distant and at a higher elevation. In some instances this variation was believed to be sufficient to explain why no mortality in the overwintering brood of bark beetles occurred in areas a few miles distant from stations where assumed killing temperatures had existed.

To secure information concerning the interrelation of elevation and temperatures in the hope of more accurately determining conditions within forested areas, a series of field experiments were established at Coeur d'Alene, Idaho; at CCC Camp F-154, Coeur d'Alene National Forest; at Birch Creek CCC Camp, Beaverhead National Forest; and at CCC Camp F-24, Shoshone National Forest. The set-up of temperature recording equipment at these locations with an analysis of the data secured is as follows:

Coeur d'Alene, Idaho

Canfield Mountain, a few miles to the north of Coeur d'Alene, which is 4,121 feet in elevation and rises rather abruptly to a height of 1,725 feet above the floor of the Spokane Valley, was utilized for the Coeur d'Alene set-up of this experiment. Stations were established at the foot of the mountain and at 500-foot intervals up the southwest slope. This slope is timbered with a rather sparse stocking of ponderosa

pine, which was sufficiently uniform to afford the same degree of protection for all of the selected stations. Self-recording maximum and minimum thermometers were set on the north side of trees, and an attempt made to secure comparable conditions at each station. Daily maximum and minimum temperature records were also available at Coeur d'Alene, Idaho.

ANALYSIS OF DATA

Coeur d'Alene, Idaho

The following tabulation shows the data secured from the Canfield Mountain experiment. When consecutive daily readings were not taken, it was necessary to visit these stations in the morning of one day in order to set the indices of the thermometers, so that readings could be taken the following morning. Data secured from such morning readings provided the maximum temperature of the previous day and the minimum of the subsequent night or the same morning. U-type maximum and minimum thermometers were used in this experiment and proved to be fairly satisfactory. The plan of this experiment called for the recording of daily temperatures during an entire period of extreme cold weather. Daily Weather Bureau records were carefully watched so as to start this experiment during the inception of the cold period.

Date	Sta. 0 2260'		Sta. I 2300'		Sta. II 2825'		Sta. III 3000'		Sta. IV 3800'		Sta. V 4125'	
1936	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
Nov. 3	30	- 29	40	-	37.5	-	36	-	39	-	35	-
Nov. 4	50	- 31		- 30		- 31		- 28		- 31		- 27
Dec. 3	37	- 21	38	-	36	-	33	-	30	-	28	-
Dec. 4	33	- 30		- 28		- 28		- 25		- 24.5		- 24.5
Dec. 28	29	- 18	32	-	30	-	24	-	23	-	20	-
Dec. 29	25	- 13	24	- 8	23.5	- 12.5	23	- 14.5	28	- 19.5	22	- 15.5
Dec. 30	28	- 20	33	- 19	29.0	- 18.5	27	- 19.5	31.5	- 19.0	26	- 18.0
Dec. 31	26	- 13	28.5	- 17.5	23.0	- 17.0	22.0	- 17.0	24.5	- 17.0	19.0	- 17.0
Jan. 1	23	- 8	23.0	- 1.5	23.0	- 9.5	17.5	- 8.0	19.0	- 8.0	16.0	- 8.5
Jan. 2	22	- 7	24.0	- 4.5	21.5	- 9.5	19.0	- 9.0	18.0	- 9.5	16.0	- 7.5
Jan. 3	30	- 8	37.5	- 3	33.0	- 9.5	31.0	- 10.5	29.0	- 10.5	29.0	- 10.0
Jan. 4	30	- 16		- 24		- 21		- 18.0		- 15.5		- 16.5
Jan. 5	18	- -2		-		-		-		-		-
Jan. 6	11	- -6	12.5	- -8.5	6.5	- -3.0	4.0	- -5.0	7.0	- -8.5	3.0	- -7.0
Jan. 7	9	- -10.5	10.0	- -16.0	8.0	- -7.5	7.0	- -7.0	9.0	- -9.0	4.0	- -7.5
Jan. 8	9	- -1	12.0	- -9.5	11.5	- -2.0	15.0	- -4.0	18.0	- -5.5	16.5	- -5.0
Jan. 9	17	- 7	18	- -1.0	16.5	- 0	18.5	- -.5	19.5	- -3.5	17.5	- -3.0
Jan.10	25	- 6	26	- 11.0	21.5	- 11.5	23.0	- 11.5	23.0	- 11.5	20.0	- 12.5
Jan.11	21	- 7	22.5	- -3.0	20.5	- 6.0	21.5	- 9.5	24.0	- 9.0	19.0	- 11.5
Jan.12	19	- 8	20.5	- .5	17.5	- 4.5	18.5	- 5.5	21.5	- 9.0	19.0	- 11.5
Jan.13	20	- 11	22.0	- 5.5	19.0	- 8.0	20.0	- 7.0	20.5	- 8.0	20.0	- 10.
Jan.14	18	- 9	19.0	- 5.5	28.0	- 7.0	27.0	- 6.5	26.0	- 5.0	25.0	- 6.0
Jan.15	18	- 15		- 15.0		- 14.0		- 14.0		- 14.0		- 14.0
Jan.20	6.5	- -13.5		-		-		-		-		-
Jan.21	8.0	- -7.0		- -17.0		- -6.0		- -6.0		- -8.0		- -7.0

Due to a misinterpretation of data the thermometers were not set on January 4, which explains the break in the otherwise continuous records.

Station I - Foot of Canfield Mountain. Southwest Exp.
Station II- 500' above Station I " "
Station III - 1000' " " " " "
Station IV - 1500' " " " " "
Station V - 1850' " " " " "

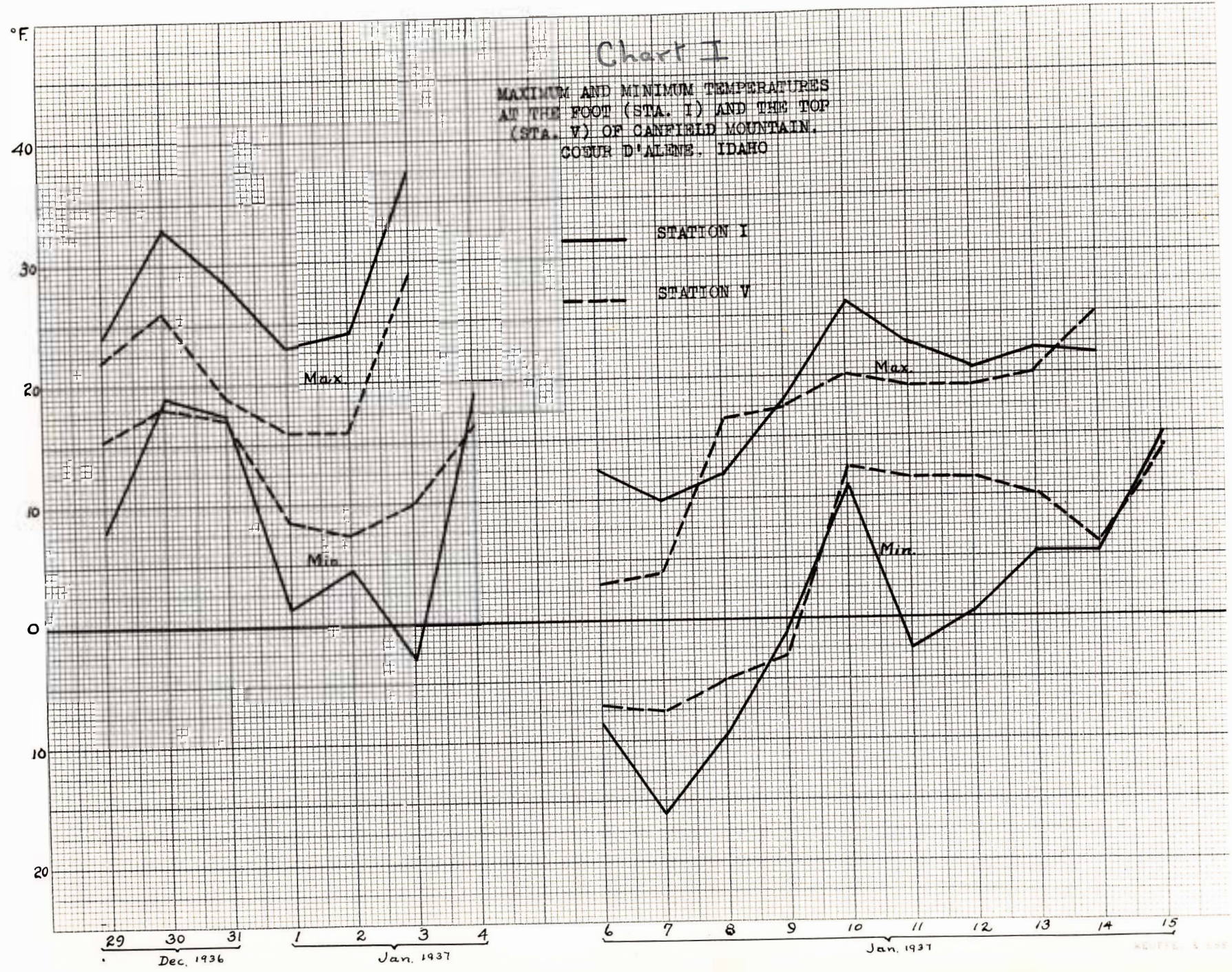


Chart I
MAXIMUM AND MINIMUM TEMPERATURES AT THE FOOT (STA. I) AND THE TOP (STA. V) OF CANFIELD MOUNTAIN. COEUR D'ALENE, IDAHO
STATION I
STATION V
°F.
40
30
20
10
0
10
20
Max.
Min.
Max.
Min.
29
30
31
Dec. 1936
1
2
3
4
Jan. 1937
6
7
8
9
10
11
12
13
14
15
Jan. 1937

Though the data in the preceding table demonstrate the existence of certain trends in the variation of temperatures for different elevations, there are discrepancies which can perhaps only be explained through the effects of local factors. Chart I shows the maximum and minimum temperatures from Stations I and V during two periods of consecutive readings. These data show the existence of a rather definite relationship in the temperatures at these two stations. It will be seen that the extremes of temperature are more pronounced at Station I at the foot of the mountain than at Station V, which is on top. Furthermore, with temperatures of 15° F. or above at Station I, cooler temperatures were recorded on top. However, with the temperature at Station I below this assumed neutral point of 15° F. warmer temperatures were recorded on top of the mountain. Exceptions to this correlation occurred on January 9, when the minimum temperature (-3° F.) at Station V was below that (-1° F.) of Station I, and again on January 14, when the maximum (25° F.) at Station V was above that (19° F.) of Station I. Local air currents are offered as an explanation of this condition.

As the data from Stations II to V inclusive did not vary to any great extent, these stations all showed the same relation to Station I as depicted by the comparison between Stations I and V. An explanation offered for the existence of comparable temperature conditions at the four upper stations is that the strata of cold air which settled into the valley and which affected the temperature at Station I was not sufficiently deep to reach Station II. Perhaps a continuation of the

cold spell which occurred, or a period of more severe cold would have increased the depth of this strata. Though these data indicate a rather positive relationship between temperature and elevation, the establishment of a definite correlation will prove to be a difficult task. Such a correlation might be established with data from a large number of stations covering much greater changes in elevation than were available on the Canfield experiment and representing a variety of conditions. However, regardless of the magnitude of the experiment, the existence of uncontrollable local and regional factors will materially influence the data secured. It would seem that the most valuable deduction to be drawn from this elementary experiment is that the problem is a very difficult one, with the only hope of a successful solution being based upon a very elaborate and expensive set-up, which in the light of our present knowledge is hardly justified.

CCC Camp F-154, Coeur d'Alene National Forest

Through the cooperation of Forest Service officials arrangements were made to have daily temperature readings taken at Camp F-154 and at a point 700 feet above. This camp is located on the North Fork of the Coeur d'Alene River, some fifteen miles north of Prichard, Idaho, and is in a heavy stand of western white pine at an elevation of 2500 feet. The second thermometer was located at a station about one-half mile to the east of the camp, at an elevation of 3200 feet. Self-recording instruments were used at these stations.

The data secured at this set-up proved to be of no practical value in determining the variation of temperatures for different elevations. Though at all temperatures there was a difference in the reading for the two stations, it was so slight and so variable as to make it of little if any value in this problem. The following tabulation serves to illustrate the inconsistency of these data:

Table II

Date	Camp station : Minimum temperatures (F)	Hill station : Minimum temperatures (F)
Jan. 18	-3	0°
19	2	2
20	-29	-24
21	-26	-18
22	-5	-3
23	9	9
28	12	11
29	-15	-16
30	-16	-11
31	-20	-22
Feb. 1	7	5

From the preceding tabulation it will be seen that from January 20 to 22 the temperature at the camp was below that recorded at the upper station. However, on January 29th and 30th it was higher. The only conclusion to be drawn from these data is that such set-ups are not sufficiently comprehensive to contribute to the solution of such problems.

Birch Creek Camp, Beaverhead National Forest

Cooperation of forest officers made it possible to secure daily

temperature data from the Birch Creek CCC camp, Beaverhead National Forest, from November 1936 to March 1937 inclusive. The Birch Creek camp is located in a lodgepole pine forest on the Birch Creek drainage at an approximate elevation of 6,600 feet. Data consisted of maximum and minimum readings at the camp and at a point some 200 feet away, but at the same elevation. A misunderstanding occurred as to the desired location of the second thermometer, and as it was located at the same elevation as the camp, the records were of no value.

Camp F-24, Shoshone National Forest

Daily temperature records from November 1936 to February 1937 inclusive were secured from CCC camp F-24, Shoshone National Forest through the courtesy of forest officers. This camp is on the North Fork of the Shoshone River, some 32 miles west of Cody, Wyoming. The elevation of the camp is approximately 6,000 feet, with the second station being to the south of the camp some 750 feet higher.

Though the temperature data from the two stations at this camp show a slight variation, the difference in elevation was not sufficient to eliminate the influence of local factors.

RELATION OF DIAMETERS TO SUBCORTICAL TEMPERATURES OF INSECT-INFESTED TREES

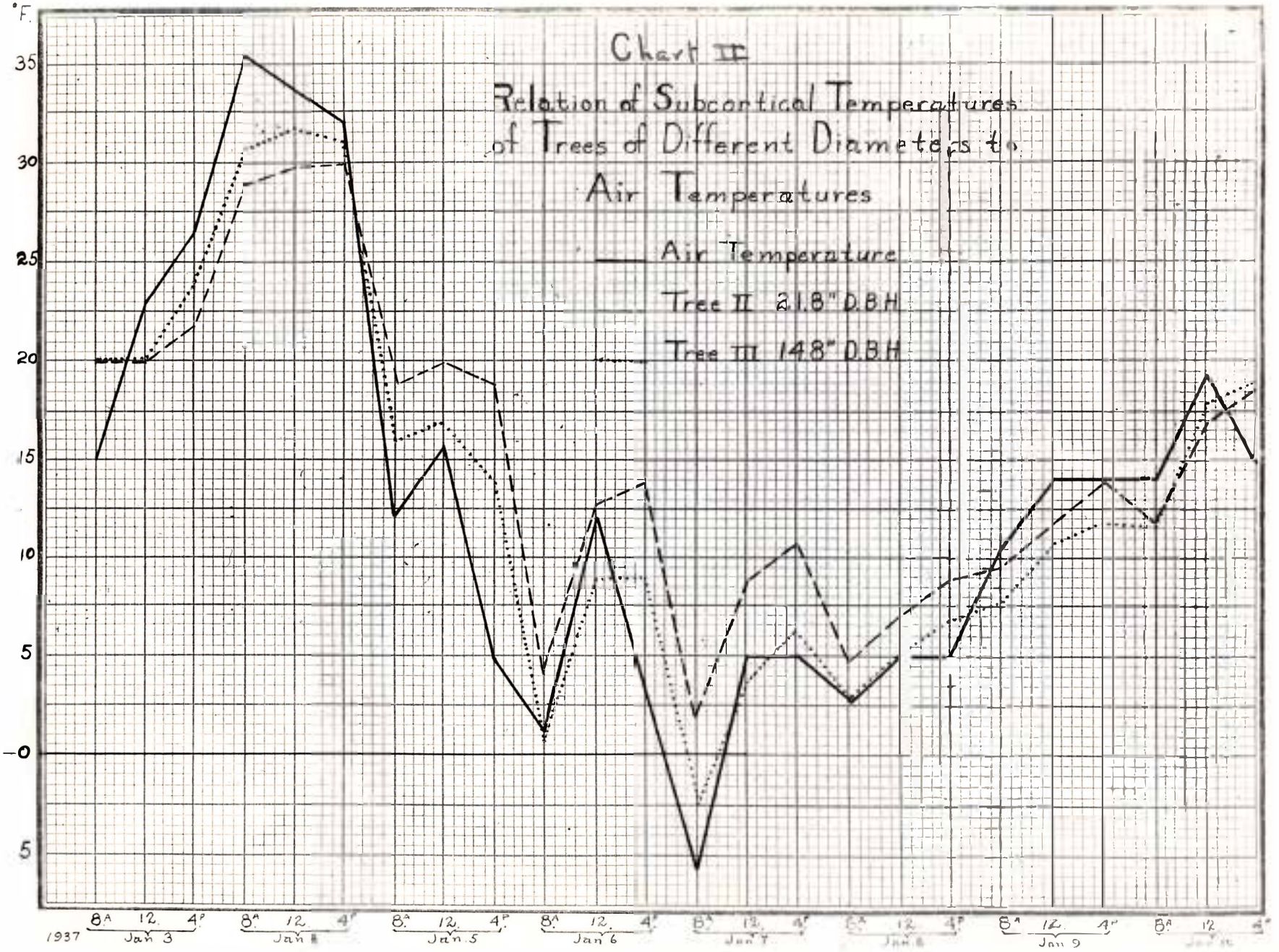
The following experiment was conducted for the purpose of determining if the diameters of infested trees influenced the lag between the subcortical or temperature beneath the bark, and that of the air. Three ponderosa pine trees infested with the western pine beetle on the

south slope of Tubbs Hill, a small promontory lying between a portion of Coeur d'Alene City and Coeur d'Alene Lake, were selected for this experiment. Thermometers were placed between the bark and wood, and at a point 2 1/2 inches in the wood in all three trees. Individual tree data were as follows:

Tree #	D.B.H.	Bark Thickness	Elevation
I	21.8	1 1/4"	2,460
II	21.8	1"	2,460
III	14.8	1"	2,310

Readings were taken from these thermometers during the inception, existence, and moderation of a period of cold weather. During this period readings were taken at different times of the day and night.

Chart II compares the subcortical temperatures of trees number II and III with the air temperature. As the data from tree No. I varied so little from No II, its inclusion in the chart was unnecessary. Readings were taken at 8 a.m., 12 p.m., and 4 p.m. The temperature lines are plotted as going direct from the 4 p.m. to the 8 a.m. reading, which obviously is incorrect. The maximum temperature for the day can not be considered as occurring at 4 p.m., nor the minimum temperature at 8 a.m. This lack of complete data is shown in some of the inconsistencies of the temperature lines which occurred between 4 p.m. and 8 a.m. However, the data secured can be taken as an indication of the trend which complete data would have followed. It will be noted that the subcortical temperature of the small tree followed the fluctuations


°F.
35
30
25
20
15
10
5
0
5
Chart II
Relation of Subcortical Temperatures
of Trees of Different Diameters to
Air Temperatures
Air Temperature
Tree II 21.8" D.B.H.
Tree III 14.8" D.B.H.
8A 12. 4P
1937
Jan 3
Jan 4
Jan 5
Jan 6
Jan 7
Jan 8
Jan 9

of the air temperature more closely than the larger tree. The temperature taken from 2 1/2 inches in the wood showed the same tendencies as the subcortical, though the responses to changes in the air temperature were not so rapid. Though this experiment indicates a relationship between the diameter of a tree and the lag between the subcortical and air temperature, the effect is not believed to be sufficient to have any great effect upon the mortality of bark-beetle broods in trees of different diameters as a result of low or unseasonal temperatures.

Data supporting this contention have been obtained from studies of different diameter logs conducted in the laboratory during the past winter. A report of these studies will be submitted in the near future.